6 PRICE ELASTICITY OF DEMAND BY FUEL

6.1 *Fuel Own-Price Elasticities of Demand*

6.1.1 Own-Price Elasticity of Demand

The own-price elasticity of the demand $\left(\varepsilon_{Q_d,P}\right)$ for a good or service (G/S) is a measure of the responsiveness of the quantity demanded of the G/S to a change in its price, all other determinants of demand held constant. It is calculated as the percentage change in the quantity demanded of the G/S divided by the percentage change in its price. $\varepsilon_{Q_d,P}$ is expected to be a negative number because if the price of a G/S increases (decreases), the quantity demanded of the G/S is expected to decrease (increase). Therefore, the price and quantity demanded of the G/S are expected to move in opposite directions and a negative $\varepsilon_{Q_d,P}$ will result. Because $\varepsilon_{Q_d,P}$ is expected to be a negative number, it is typically written as positive number for convenience and its negativity is assumed (this convention is employed in this report).

Based on the value of $\varepsilon_{Q_d,P}$, the demand for a G/S is described as inelastic, elastic, or unitary elastic. If $\varepsilon_{Q_d,P} < 1$, demand is said to be inelastic; that is, the quantity demanded of the G/S is relatively unresponsive to a change in its price (the percentage change in the quantity demanded of the G/S is less than the percentage change in its price). On the other hand, if $\varepsilon_{Q_d,P} > 1$, demand is said to be elastic; that is, the quantity demanded of the G/S is relatively responsive to a change in its price (the percentage change in the quantity demanded of the G/S is greater than the percentage change in its price). And if $\varepsilon_{Q_d,P} = 1$, demand is said to be unitary elastic. $\varepsilon_{Q_d,P}$ will equal one if the change in the quantity demanded of the G/S equals the change in its price.

6.1.2 Primary Determinant of the Own-Price Elasticity of Demand

$\varepsilon_{Q_d,P}$ is primarily determined by the availability of substitutes. To consider the effect of the availability of substitutes on $\varepsilon_{Q_d,P}$, it is necessary to consider $\varepsilon_{Q_d,P}$ of a given demand for a G/S, as well as $\varepsilon_{Q_d,P}$ of two different demands for a G/S, short run and long run demand. In any case, the more substitutes there are for a G/S, the more responsive quantity demanded of the G/S is expected to be to a change in the price of the G/S.

A Typical Demand Curve has Both Elastic and Inelastic Regions

In the case of a given demand for a G/S, the fact that $\varepsilon_{Q_d,P}$ is primarily determined by the availability of substitutes does not necessarily mean $\varepsilon_{Q_d,P}$ is constant at all prices. The demand for most G/S is elastic over one range of prices and inelastic over another range of prices.

In the cases of many G/S, demand is inelastic at high prices and elastic at low prices. The idea is that a G/S is purchased for a variety of purposes, but as the price of the G/S increases, the G/S will continue to be purchased only for those purposes for which there are only poor substitutes.

In the cases of other G/S, demand is elastic at high prices and inelastic at low prices. The idea is that consumers are more willing to switch to/from substitutes at high prices than at low prices. Substitutes for a G/S are imperfect. These imperfections are likely to seem less important the higher the price of the G/S, but more important the lower the price of the G/S.

The Short Run Versus the Long Run Demand for a G/S

To consider the effect of the availability of substitutes on $\varepsilon_{Q_d,P}$, it is also necessary to consider $\varepsilon_{Q_d,P}$ of two different demands for a G/S, short run and long run demand. A G/S is expected to have more viable substitutes the longer the time period under consideration. Recall, $\varepsilon_{Q_d,P}$ is a measure of the responsiveness of the quantity demanded of a G/S to a change in its price, all other determinants of demand held constant—including the length of the time period under consideration. Therefore, the effect of the availability of substitutes on $\varepsilon_{Q_d,P}$ is also captured by distinguishing between the $\varepsilon_{Q_d,P}$ of two different demands, where the long run $\varepsilon_{Q_d,P}$ is expected to be larger than short run $\varepsilon_{Q_d,P}$.

6.1.3 Own-Price Elasticities of Demand Employed in the BGC Energy Demand Model

The BGC energy demand model requires estimates of the short run own-price elasticities of the demands for the fuels gas, electricity, and oil. Currently, the model employs two estimates of the short run $\varepsilon_{Q_d,P}$ for fuel, one for residential, non-apartment customers and another for commercial, industrial, and apartment customers. For residential, non-apartment customers, the short run $\varepsilon_{Q_d,P}$ is assumed to be 0.1 for all three fuels. And for commercial, industrial, and apartment customers, the short run $\varepsilon_{Q_d,P}$ is assumed to be 0.15 for all three fuels. Therefore, BGC's energy demand model currently posits the short run demands for all three fuels are inelastic (less than one) for all customer types, but slightly more inelastic for residential customers.

Although BGC's energy demand model currently employs only two estimates of fuel short run $\varepsilon_{Q_d,P}$, the model can handle estimates at any level of detail. For example, short run $\varepsilon_{Q_d,P}$ that vary by fuel, geographic region, end-use, and/or industry. Consequently, our review of the literature for estimates of fuel short run $\varepsilon_{Q_d,P}$ considered all such estimates at any level of detail.

6.2 *The Literature Review*

The estimates of fuel short run $\varepsilon_{Q_d,P}$ BGC's energy demand model currently employs are based on the data that were available as of 1991. Therefore, our review of the literature focused on estimates of fuel short run $\varepsilon_{Q_d,P}$ that have become available since 1991.

We searched a wide variety of databases for documents that contained "price" near "elasticity" and also contained "gas," "electricity," "oil," or "fuel." The databases we searched consisted of:

- articles in energy and utilities trade publications,

- citations and abstracts to economics research (e.g., journal articles, books, working papers),
- doctoral dissertation abstracts, and
- government publications.

In addition, we checked for any fuel short run $\varepsilon_{Q_d,P}$:

- employed by the New England Governors Conference forecasting model (or the Massachusetts SAFER model), or
- included in recent Massachusetts regulatory filings.

The potential sources we reviewed included articles from trade publications, articles from the economics literature, government publications, the Massachusetts SAFER model, and recent Massachusetts regulatory filings.

For purposes of this study, an estimate of $\varepsilon_{Q_d,P}$ for a fuel was determined to be a short run estimate, if it was based on changes in the quantity demanded of the fuel to changes in the price of the fuel that were no longer than annual changes. If there was insufficient information to determine whether or not an estimate of $\varepsilon_{Q_d,P}$ for a fuel was a short run estimate, a clear statement that it was short run estimate was taken as evidence.

6.3 *Recommendations Regarding Fuel Short Run Own-Price Elasticities of Demand*

6.3.1 Gas

Literature Review Results

The following table contains the estimates of gas short run $\varepsilon_{Q_d,P}$ we found in the literature:

Table 1
Gas Short Run Own-Price Elasticities of Demand

Reference	Time Period Analyzed	Geographic Market	Natural Gas			
			Residential (res)		Commercial (com)	Industrial (ind)
Lemon 1992	n.a.	n.a.	Res demand (D) may be somewhat--not far--more inelastic than ind D. W/competition => choice, res D will be more elastic.			
Taheri 1994	1974-1981	U.S.		n.a.	n.a.	0.00
WEFA Group 1996	1978-1995 (or a subset)	CGC div.[a] in MA	Heating	Non-htg		
		Cambridge	0.13	0.00	0.00	n.a.
		Framingham	0.16	0.21	0.17	0.00
		New Bedford	n.a.	0.12	0.26	n.a.
		Worcester	n.a.	0.12	0.21	n.a.

Note: n.a. = not applicable.
[a] CGC div. = Commonwealth Gas Company divisions.

Lemon's (1992) position that residential demand for gas may be somewhat more inelastic than industrial demand for gas is not supported by either paper providing estimates of gas short run $\varepsilon_{Q_d,P}$. Both papers estimate industrial short run demand for gas to be perfectly inelastic ($\varepsilon_{Q_d,P}$ = 0.00).

Based on the WEFA Group (1996) estimates of gas short run $\varepsilon_{Q_d,P}$, the range of these estimates for classes other than the industrial class are as follows:

- residential heating, 0.13-0.16;
- residential non-heating, 0.00-0.21; and
- commercial, 0.00-0.26.

The midpoints of these ranges are residential heating, 0.145; residential non-heating, 0.105; and commercial, 0.13.

It is surprising there is very little consistency with respect to the relative elasticities of the residential heating, residential non-heating, and commercial short run demands for gas across the four Commonwealth Gas Company divisions. For example, residential non-heating short run demand for gas may be equally (Cambridge), more (Framingham) or less (New Bedford, Worcester) elastic than the commercial short run demand for gas.

Recommendation

Recall, currently, the BGC energy demand model employs two estimates of gas short run $\varepsilon_{Q_d,P}$, 0.10 for residential, non-apartment customers and 0.15 for all other customers. Based on what we've been able to find and review regarding the estimates of gas short run $\varepsilon_{Q_d,P}$, we recommend no changes to these estimates